

VELARDEÑITE FROM A NEW LOCALITY IN TULARE COUNTY, CALIFORNIA.

By EARL V. SHANNON,

Assistant Curator, Department of Geology, United States National Museum.

INTRODUCTION.

Dr. Esper S. Larsen recently forwarded to this department for accession and chemical investigation some specimens which had been received at the United States Geological Survey from Tulare County, California. (Cat. No. 94342, U.S.N.M.) These specimens, which when received were labeled "uranium ore," were examined optically by Doctor Larsen and found to be composed chiefly of a mineral of the melilite group. This mineral has since been analyzed in the Museum laboratory and proves to consist largely of the end member of the melilite group named velardeñite by Schaller. The California material is very similar in composition to that from Velardeña, Mexico, upon which the species velardeñite was instituted.

PHYSICAL PROPERTIES AND ASSOCIATED MINERALS.

In the hand specimen the material is coarse-granular and is dull olive-green in color except near certain narrow veins about .3 mm. in thickness which traverse the specimens. These veins are filled with a white porcellanous material, on either side of which for a space of about 5 mm. the color of the velardeñite is pitch-black. An occasional grain shows well-defined cleavage. The luster is greasy to resinous. Under a lens the specimen is seen to be dotted with small grains of garnet which have a yellow-green color, which distinguishes them from the duller green velardeñite.

In this section the velardeñite makes up a fabric of coarse interlocking grains. It is colorless except near the narrow veinlets. The latter are white and practically opaque under the microscope and probably consist of cryptocrystalline silica. Near them the velardeñite is thickly dusted with a very finely disseminated brownish-black material. The larger grains of velardeñite frequently show a well-defined cleavage in one direction with a rather perfect parting at right angles to the cleavage. Scattered throughout the section are small irregular grains of isotropic yellow-green garnet. These occur both as irregular tongue-like grains between the crystals of velardeñite and as small inclusions in the crystals of velardeñite. The garnet grains inclosed in the velardeñite crystals are in many in-

stances crudely rectangular, their borders coinciding with the cleavage and parting of the surrounding velardeñite. In less amount there occurs intergrown with the garnet and also disseminated in grains in velardeñite, another isotropic mineral having a pale brown color in thin section. This has an index of refraction slightly lower than that of the garnet and is doubtless spinel. The total volume of the minerals other than velardeñite in the specimens is less than 5 per cent of the whole. The only other mineral identified is magnetite, which occurs in disseminated euhedral grains.

OPTICAL PROPERTIES.

The velardeñite is colorless as seen under the microscope. It is uniaxial and negative. The indices of refraction as determined by immersion are:

$$\omega = 1.657 \pm .002$$

$$\epsilon = 1.653 \pm .002$$

$$\omega - \epsilon = .004 \pm .002$$

In thin section the mineral polarizes in grays, in sections of approximately .03 mm. thickness. Where garnet occurs in the velardeñite, however, there is a halo in the velardeñite around the garnet grains which has higher birefringence as though some constituent of the garnet had diffused into the other mineral for a short distance and had increased its birefringence.

CHEMICAL PROPERTIES.

The mineral is readily soluble in acids with separation of gelatinous silica. Pure material for analysis was secured by separation with heavy solutions. Upon analysis this purified material gave the results tabulated in column 1 below. In column 2 are given the figures obtained by E. T. Allen upon the material from Velardeña, Mexico, described by Wright.¹

Analyses of Velardeñite from California and Mexico.

	(1) California.	(2) Mexico
SiO ₂	27.88	26.33
TiO ₂03
Al ₂ O ₃	25.52	27.82
Fe ₂ O ₃	1.59	1.43
FeO.....	.43	.50
MnO.....		.01
MgO.....	4.18	2.44
CaO.....	40.86	39.55
Na ₂ O.....		.21
K ₂ O.....		.10
H ₂ O.....	.34	1.85
	100.80	100.27

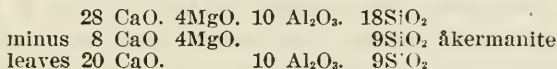
¹ Wright, F. E., Amer. Journ. Science, vol. 26, p. 547, 1908.

The analysis of the California material gives the following ratios:

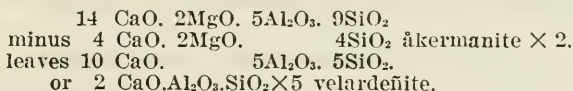
Ratios of Velardeñite from California.

SiO ₂4623	} 46.23	.99×9
Al ₂ O ₃2497		
Fe ₂ O ₃0100	} 25.97	1.00×5
FeO.....	.0060		
CaO.....	.7285	} 73.45	1.01×14
MgO.....	.1032		
		} 10.32	1.00×2

The composition of the material is thus capable of expression by the formula $14\text{CaO} \cdot 2\text{MgO} \cdot 5\text{Al}_2\text{O}_3 \cdot 9\text{SiO}_2$. The velardeña material was interpreted by Schaller² as an isomorphous mixture of åkermanite, for which he adopted the formula $4\text{MgO} \cdot 8\text{CaO} \cdot 9\text{SiO}_2$, and velardeñite to which he assigned the formula $2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$. Taking the present mineral as of similar constitution and using the magnesia as an index to the åkermanite present it gives:



Taking for the formula for åkermanite the $2\text{CaO} \cdot \text{MgO} \cdot 2\text{SiO}_2$ found by Ferguson and Merwin³ the following results are obtained:



It thus appears that the California mineral consists of velardeñite and åkermanite in the ratio of 5 parts of the former to 2 of the latter or of 71.6 per cent by weight of velardeñite and 28.4 per cent of åkermanite. Schaller calculated that the Mexican material contained 80 per cent of velardeñite and 20 per cent of åkermanite.

The artificial compound $2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$ was first prepared artificially by Weyberg and later by Shepherd and Rankin. Schaller, in his theory of the melilite group,⁴ showed that all of the chemical peculiarities of the various members of the group could be explained by interpreting the minerals as isomorphous mixtures of four end members, namely, sarcolite ($3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{SiO}_2$), a theoretical soda sarcolite ($3\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{SiO}_2$), velardeñite ($2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$), and åkermanite ($4\text{MgO} \cdot 8\text{CaO} \cdot 9\text{SiO}_2$). The end member velardeñite was found to occur in excess in material called gehlenite from several localities, but since the name gehlenite had obviously been given to an intermediate mixture of two or more end members it was recommended that this name be discarded. This series of minerals has

² Schaller, W. T., Bull. U. S. Geol. Survey No. 610, p. 106, 1916.

³ Ferguson, J. B., and Merwin, H. E., Proc. Nat. Acad. Sci., vol. 5, p. 18, 1919.

⁴ Schaller, W. T., U. S. Geol. Surv. Bull. 610, pp. 106-129, 1916.

been extensively investigated by the geophysical laboratory of the Carnegie Institution of Washington, and their results have, in the main, confirmed Schaller's theory as to the constitution of the group and the composition of the end members. A discrepancy in nomenclature has arisen, however, which is very confusing. This is due to the fact that the men working on the synthetic compounds of this group have disregarded the name velardeñite and have transferred the name gehlenite to this compound. Until some explanation is advanced to justify the deviation from the nomenclature of Schaller, to whom we are indebted for the correct interpretation of the melilite group, natural minerals approaching the pure end member $2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$ may correctly be called velardeñites.

COMPOSITION OF THE GARNET.

A small amount of a concentrate, consisting largely of the garnet which occurs associated with the velardeñite, was isolated with heavy solutions. The portion was small, and in addition to the garnet contained also spinel, which is almost identical with the garnet in specific gravity. One portion only was available, and the state of oxidation of the iron was not determined. It is below assumed to be entirely in the ferric state. An analysis of this small portion of material gave the following composition and ratios:

Analysis and ratios of garnet (with spinel).

Constituent.	Per cent.	Ratios.		
SiO_2	32.66	0.5416	54.16	0.90×3
Fe_2O_3	24.15	.1512	} 20.94	} 1.04×1
Al_2O_3	5.95	.0582		
CaO	35.51	.6331	} 69.73	} 1.16×3
MgO	2.59	.0642		

The ratios are not satisfactorily close to whole numbers, thus indicating a considerable admixture of spinel. Assuming the greater part of the magnesia and alumina to be present in this form, it is evident that this yellow-green garnet is very largely composed of the lime-ferric iron molecule andradite.

LOCALITY AND OCCURRENCE.

The locality for the material is not known more definitely than simply Tulare County, California, and no information regarding the occurrence is available other than that furnished by the specimens themselves. It seems most probable that the velardeñite and associated minerals are here, as in Mexico, products of the contact metamorphism of limestone.